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# A Comparison Study of Strength Training Outcomes Between Progressive Resistive Training and Regressive Resistive Training

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A COMPARISON STUDY OF STRENGTH TRAINING OUTCOMES BETWEEN  
PROGRESSIVE RESISTIVE TRAINING AND REGRESSIVE RESISTIVE  
TRAINING

by

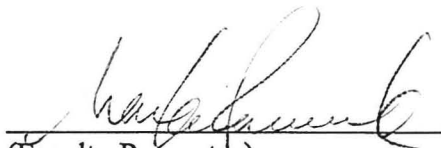
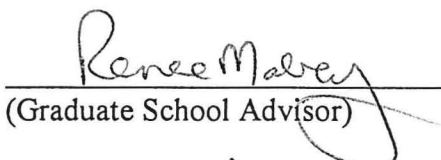

Carrie Brossart  
Bachelor of Science in Physical Therapy  
University of North Dakota, 1997

An Independent Study  
Submitted to the Graduate Faculty of the  
Department of Physical Therapy  
School of Medicine  
University of North Dakota  
in partial fulfillment of the requirements  
for the degree of  
Master of Physical Therapy

Grand Forks, North Dakota  
May  
1998



This Independent Study, submitted by Carrie Brossart in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

  
(Faculty Preceptor)  
(Graduate School Advisor)  
(Chairperson, Physical Therapy)

## PERMISSION

Title                    A Comparison Study of Strength Training Outcomes Between  
Progressive Resistive Training and Regressive Resistive Training

Department            Physical Therapy

Degree                Master of Physical Therapy

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Date 12/9/97



## TABLE OF CONTENTS

List of Tables . . . . .	v
Acknowledgements . . . . .	vi
Abstract . . . . .	vii
Chapter I: Introduction/Literature Review . . . . .	1
Chapter II: Methodology . . . . .	10
Chapter III: Results . . . . .	15
Chapter IV: Discussion . . . . .	19
Chapter V: Conclusion . . . . .	23
Appendix . . . . .	24
References . . . . .	33

## LIST OF TABLES

Table	Page
1. Descriptive Statistics of Progressive Resistive Group . . . . .	16
2. Descriptive Statistics of Regressive Resistive Group . . . . .	17
3. Analysis of Covariance (ANCOVA) . . . . .	18

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## ABSTRACT

The purpose of this study was to determine whether there is a difference in strength training outcomes between the progressive resistive program and the regressive resistive program. The subjects consisted of 14 students at the University of North Dakota. They were randomly assigned to either the progressive or regressive group and performed their respective training two times per week for five weeks. Each subject was tested prior to beginning the program and after finishing the program. These pretest and posttest values were compared to determine strength gains. A paired samples t-test was used to determine that each group had significant strength gains; however, the analysis of covariance (ANCOVA) statistical test showed no significant difference between groups in producing strength gains. The author described limitations of the study and stated that with a greater number of subjects and increased training time, the results may have been more significant.

## CHAPTER 1

### INTRODUCTION/LITERATURE REVIEW

It has been well known for centuries that resistance exercise enhances muscle strength.<sup>1</sup> Resistive training is one of the fastest growing physical activities in the country today and is widely used by bodybuilders, as training for athletes, as a means of rehabilitation after injury, and for general physical fitness.<sup>1,2</sup> This relationship between resistance exercise and strength has resulted in medical professionals, coaches, and athletes trying many combinations and techniques of resistance exercise in an attempt to find the most effective means to produce muscle overload, the real key to building strength.<sup>3</sup> Hellebrandt<sup>3</sup> defines the overload principle by stating that “a muscle grows larger and stronger only when it is required to perform tasks that place loads on it which are over and above previous requirements.”

There are several techniques of performing resistance exercises that have been developed, two of which are progressive resistive exercise and regressive resistive exercise. In ancient Greece, Milo the wrestler used a progressive resistive exercise program, which consisted of lifting a calf each day until it reached its full weight.<sup>1</sup> This is probably the earliest example of progressive resistive exercise. Thomas Delorme<sup>4</sup> was a captain in the U.S. Army during WWII and treated many patients with wasting and weakness of muscles after injury. He developed a method of progressive resistive

exercise in 1945, which included 10 sets of 10 repetitions each.<sup>3</sup> A set is defined as a group of repetitions of a particular movement or exercise.<sup>1</sup> A repetition is one of a number of consecutive times a particular movement or exercise is performed.<sup>1</sup> During the first set, the patient lifted 10% of their 10 repetition maximum (RM) and then continued to increase each set by 10% of the 10RM.<sup>3</sup> A repetition maximum is the most weight that can be lifted in one repetition using correct form. A 10RM is the most weight that can be lifted 10 times. The last (tenth) set would be 100% of the 10RM. Delorme revised this program in 1948. This new program consisted of three sets of 10 repetitions. The sets were performed by lifting, in sequence, 50%, 75%, and 100% of the 10RM. McMorris and Elkins<sup>3</sup> developed a similar program in which the patient lifted four sets of ten repetitions using 25%, 50%, 75%, and 100% of the 10RM. All of these programs are progressive resistive exercises as they are based on a light to heavy system.

Regressive resistive exercise is simply the reverse of the progressive resistive program, as it is a heavy to light system. The heaviest set is performed first and the lightest set last. This system is also called the Oxford technique.<sup>5</sup> Three sets of 10 repetitions are performed lifting 100% of the 10RM, 75% of the 10RM, and finally 50% of the 10RM. Oxford originally designed this program to consist of 10 sets of 10 repetitions as Delorme did with his program.<sup>3</sup> Oxford's technique was modified by McMorris and Elkins and again by McGovern and Luscombe to the three set program.

### *Overload*

As stated earlier, overload is the real key to building strength. Overload is defined as the workload for a muscle or muscle group that is greater than that to which

the muscle is accustomed.<sup>1</sup> The fact that increases in muscle fiber size occur in response to overload such as resistance training has been well established.<sup>6</sup> Strength improvements are determined by the intensity of overload, not by the specific technique.<sup>7</sup> In progressive resistive exercise overloading is achieved by increasing the weight lifted in each set.<sup>8</sup> During the last set, the patients lift their 10RM so the muscle is working to its full capacity. However, since the first two sets consist of weights less than the 10RM, the muscle is not working to full capacity until the final set. In regressive resistive exercise, the patient's 10RM is lifted during the first set. The second and third sets will utilize decreased resistance, more closely following the fatigue curve. Therefore, the patients are lifting the lightest set when they are the most fatigued. They are still lifting to their maximum capacity, in light of fatigue's impact.<sup>9</sup>

In a study by Berger and Hardage<sup>1</sup> involving training two groups of men, one group lifted a standard 10RM set. The other group lifted a 1RM set for each of 10 repetitions. These subjects performed their set by beginning with a 1RM repetition and reducing the weight for each subsequent repetition to account for fatigue. For the second group, the weight was progressively reduced to account for the muscle fatigue. The maximal overload group showed significantly greater strength increases than the standard 10RM group. These results support the theory that the intensity of the work is an important factor in building strength. They also support the idea that adjusting resistance to parallel fatigue to allow the maximum 1RM for each repetition would be the ideal technique for building strength. Regressive resistive exercise does not allow for a repetition maximum lift during each repetition; but it does allow for a maximum 10RM during each set. Progressive resistive exercise does not do this. The last repetition of

each set is more likely to be a maximal voluntary muscle contraction (the last repetition before the weight could no longer be lifted at a particular velocity and predetermined form) with the regressive resistive program than with the progressive resistive exercise. This is due to the muscle fatigue produced by the first set. Most research supports the idea that maximal contractions are more effective than submaximal contractions in producing strength gains.<sup>5</sup> In theory, there is more overload taking place with the regressive resistive exercise; therefore, greater strength gains should be expected from this training program as compared to the progressive resistive program.

### *Muscle Physiology*

Muscular growth due to overload occurs from a hypertrophy of individual muscle fibers. Hypertrophy is the result of the synthesis of cellular material.<sup>7</sup> Within the cell, myofibrils thicken and increase in number and sarcomeres are formed. Hypertrophy of muscles appears to be a result of an increase in tension or force a muscle produces. Besides increasing the size of muscle fibers, muscular overload also strengthens connective tissue and improves structural and functional integrity of tendons and ligaments. These results of overload all provide protection from joint and muscle injury, supporting the use of resistance exercise in preventative and rehabilitative strength programs.

### *Muscle Cross-Sectional Area*

The force a muscle is able to produce is directly related to its cross-sectional area, not to its volume.<sup>10</sup> A body made of more muscle and less fat has the potential to exert



more force. If two athletes with similar body fat but different heights have the same biceps circumference, their upper arm muscle cross-sectional areas are nearly equal. Although the taller athlete is heavier and has a larger muscle with greater muscle volume, the athletes' biceps should be about equal in strength. An increased cross-sectional area of muscle fibers results from increased actin and myosin filaments added to myofibrils. Heavy resistance training causes increased cross-sectional areas of both type I and type II muscle fibers. Several studies have found that cross-sectional area of the fast-twitch (type II) fibers increases more than that of the slow-twitch (type I) fibers as a result of resistance training. The potential for hypertrophy may depend on the relative proportion of fast-twitch fibers in a person's muscle. Muscle fibers are classified according to twitch time. Slow-twitch fibers develop force slowly and have a long twitch time. They are fatigue resistant and have a high aerobic capacity for activities such as running. They have little potential for rapid force development or anaerobic power. Fast-twitch fibers develop force rapidly and have a slow twitch time. They are quickly fatigued and have low aerobic power. They can develop force rapidly and have high anaerobic power for activities such as weight training. A person with a low proportion of fast-twitch fibers may have a low potential to gain muscle mass with resistance training. Resistance training is the most effective form of exercise in producing muscle fiber hypertrophy. During the first 1 to 2 months of training, previously untrained people will experience strength gains but not muscle hypertrophy. Neural adaptations have to take place first to allow for the increased strength. These adaptations are responsible for strength gains during the first few weeks of training. Previously trained muscle may respond more quickly to resistance exercise with increases in muscle fiber size. After this initial period

of adaptation, hypertrophy begins to take place and contribute to increases in strength. One study measured muscle cross-sectional area of the vastus lateralis muscle before and after 6 weeks of heavy resistance exercise and found it to increase by 8.4%, mainly during the second half of the training period.<sup>11</sup> Another study found the quadriceps cross-sectional area after 6 months of training to increase by 18.8% +/- 7.2% distally, 19.3% +/- 6.7% proximally, and 13.0% +/- 7.2% centrally.<sup>12</sup>

### *Neural Adaptation*

Strength is not only determined by the size of the muscles, but also by the ability of the nervous system to activate the muscles.<sup>6</sup> The agonist, synergist, and antagonist muscles must all be activated for a force to be produced. With each muscle contraction, the nervous system determines which and how many motor units are recruited and the rate at which they are fired.<sup>10</sup> A greater muscle force is produced when more motor units are recruited, the motor units are larger, or the rate of firing is faster. The initial increase in strength during the first few weeks of a weight training program is the result in part of the adaptive changes taking place in the nervous system, the system controlling the muscles performing the exercise.<sup>6</sup> These adaptive changes the nervous system makes in response to training are referred to as neural adaptation. The neural factors believed to have an effect on muscular force production include increased neural drive to the muscle, increased synchronization of the motor units, increased activation of the contractile apparatus, and inhibition of the protective mechanisms of the muscle.<sup>5</sup> During the first few weeks of performing a new training exercise, it is neural adaptation that is primarily responsible for strength increases. Increases that take place after this adaptation period

are due primarily to muscle hypertrophy.<sup>5,6</sup> A study which consisted of eight weeks of isotonic strength training found that neural factors were responsible for a larger portion of the initial strength gain, and hypertrophy was the dominant factor after 3 to 5 weeks.<sup>13</sup> Delorme and Watkins<sup>5</sup> proposed that: "The initial increase in strength from progressive resistance exercise occurs at a rate far greater than can be accounted for by morphological changes within the muscle. These initial rapid increments in strength noted in normal and disuse-atrophied muscles are, no doubt, due to motor learning..." One study found that training produced a 92% increase in strength but only a 23% increase in muscle cross-sectional area.<sup>5</sup> Researchers have concluded based on these types of findings that neural factors have a significant influence on muscular strength gains. Neural adaptation potential decreases as training continues; therefore, the design of an effective program becomes essential. For example, muscle fiber cross-sectional area may increase by 40% in the first year of training, but by only 5% during the next year.<sup>10</sup> After months or years of training, the inability to elicit further adaptations may prevent strength increases.

There is very little research comparing the progressive and regressive systems; however, studies that have been done tend to support the regressive system as the more effective one in producing strength gains. The theory behind progressive resistive exercise is that the muscle or muscle group is forced to work to full capacity against increasing resistance. This increasing resistance causes an increase in intramuscular tension, which in turn leads to an increase in muscle strength.<sup>14</sup> The effectiveness of this method has been examined and proven many times and has also served as a control condition in testing other methods.<sup>15</sup> According to McArdle et al,<sup>7</sup> "The technique of

progressive resistive exercise is a practical application of the overload principle and forms the basis of most resistance training programs.” The problem found in the clinic when this program was applied to patients was that the final set, the heaviest, was often too difficult to perform properly.<sup>9</sup> Muscle fatigue prevented the patient from completing the full range of motion during the final repetitions and often caused pain. This difficulty is what prompted Zinovieff to develop the Oxford (regressive resistive) technique. With this program the final set is the lightest set, a design which should eliminate the problems found with the progressive system. As fatigue is increasing, the weight is reduced, so that in theory the patients are lifting their 10RM during all three sets; and therefore, the muscle is exercised to its maximum capacity.<sup>9, 16</sup> McMorris and Elkins<sup>15</sup> compared the Delorme and Oxford methods and found the Oxford method to be better; but the differences were small. Leighton and his colleagues<sup>15</sup> performed a study comparing 10 strength training methods including both the progressive resistive and regressive resistive techniques. They found the regressive technique (.97% to 1.12% gains per session) to be superior to the progressive technique (.52% gains). One study found the regressive resistive program better than the progressive at producing strength gains, but indicated that further research is necessary.<sup>5</sup>

Since there is little published data comparing these methods, the purpose of this pilot study is to examine if there is a difference in strength gains produced by the progressive resistive program and the regressive resistive program. The results of this study are significant to physical therapists who are under increasing demands to find the most efficient methods of rehabilitating their patients, as current reimbursement trends

are allowing them fewer visits and shorter time frames. They are also significant to body builders and competitive athletes searching for the most effective way to build strength.

## CHAPTER 2

### METHODOLOGY

#### *Subjects*

The subjects who participated in this study included seven females and seven males, all students at the University of North Dakota. One male subject was unable to complete the study due to an injury from another activity. The subjects were of varying heights and weights and ranged in age from 21 to 40 years. Some of them had been weight training previous to participating in this study and others had not. All subjects were volunteers, and there was no inclusion or exclusion criteria in choosing them other than being physically able to lift weights. The subjects were randomly assigned to one of the strength training programs, either progressive resistive or regressive resistive. All subjects signed an information and consent form prior to participating in this study.

#### *Instrumentation*

The only equipment used in this study was free weight equipment including preacher curl benches, bars, and weights. Some subjects performed their training on equipment in the Hyslop Sport Center at the University of North Dakota (Pro-Class Gym Equipment, 301 University Dr, Macomb, Ill. 61455), and others at the Grand Forks Racquetball and Tennis Center (Body Solid, Eisenhower Lane S., Lombard, Ill. 60148). This equipment was used for both the testing procedures and the actual training

programs. McArdle et al<sup>7</sup> refer to the 1RM test with free weights as a reliable and valid assessment of strength. The author chose to use a 3RM test rather than a 1RM to assess strength for safety reasons. There is less risk of a muscle strain with the 3RM test.

### *Procedure*

During the first session, all subjects were instructed in and asked to perform a three repetition maximum biceps curl lift using the preacher bench, bar, and weights. The preacher bar and bench were used in order to assure isolation of the biceps muscles and avoid any substitution from the back extensors or shoulder elevators. Sitting in the correct position on the preacher bench does not allow the subject to lean back or use the shoulder muscles as standing or sitting without the bench may. The subjects first chose a weight that they thought could be lifted three times. If three repetitions were completed with proper form, more weight was added to the bar. When the subject felt adequately recovered, three repetitions were performed again. This procedure was repeated until the subject failed to lift the weight three times. The heaviest weight the subject was able to lift three times was recorded as the 3RM and served as the pretest value. The subjects returned one week later for the second session during which they were each assigned to either the progressive resistive program or the regressive resistive program. They were then instructed on how to perform these programs. Both groups were to perform three sets of ten repetitions of the biceps curl using the same equipment with which they were previously tested. Subjects in the progressive resistive program were to perform their first set lifting approximately 50% of their 10RM, their second set lifting approximately 75% of their 10RM, and their third set lifting 100% of their 10RM. Since the lightest

free weight weighs 2.5 lbs, the weights had to be added in 5lb increments (2.5 on each side); therefore, it was not always possible to add exactly 50% or 75% of their 10RM. After finding their 10RM, those assigned to the regressive resistive program were to perform their first set lifting 100% of their 10RM, their second set lifting approximately 75% of their 10RM, and their third set lifting approximately 50% of their 10RM. All subjects were asked to first find their 10RM and then perform their three sets accordingly after a sufficient rest period. To find the 10RM, as much weight as possible was lifted for 10 repetitions. Weight was added to the bar until failure to lift it 10 times occurred. The weight lifted just previous to the failure set was recorded as the 10RM. After each subject performed the appropriate three sets, resistance weights were recorded on a data sheet which was issued to them so they could record the dates of each training session and the weights lifted. They were asked to return within one week to perform those same three sets and twice per week for the following four weeks for a total of five training weeks. All subjects were instructed to remain at those same weights for two weeks. They were told they could follow their own weight program for any other lifts they would like to perform, but could not perform any biceps lifts other than their assigned program.

At the end of two weeks, the subjects were instructed to increase their weights if possible. They were only to increase if they were able to add weight to their heaviest set and still perform 10 repetitions. They were to increase the other two sets accordingly as to still remain at the 50%, 75%, and 100% intervals. If they were unable to increase their heaviest set, they were asked to remain at their previous weights. Those subjects who were unable to increase were instructed to increase whenever they were ready. At the



end of four weeks on their programs, all subjects were instructed to increase their weights again, if able, using the same guidelines as the first increase.

### *Data Analysis*

The pretest values were used as a baseline measurement of strength for all subjects. A t-test for paired samples was used to determine if there were significant strength gains within each individual group (progressive and regressive). The means and standard deviations were calculated for each group before and after the five week training session. These values were compared to see whether increases occurred in each group.

Because of variability in pretest and posttest values ( $p \leq .05$ ), comparisons of strength gains between the two groups were made using analyses of covariance (ANCOVA).<sup>17,18</sup> This test determined whether there was a significant difference in postexercise strength values between groups while accounting for a difference in the pretest values. The initial variability is due to both groups including males and females, which resulted in a wide range of pretest values in each group. The ANCOVA is a statistical procedure used to control for initial differences between groups. The independent variable in this study was the type of strengthening program (progressive or regressive). The dependent variable was the amount of weight (lbs) the subject was able to lift three times (3RM). ANCOVA can adjust scores on the dependent variable for the initial differences on another variable. In other words, ANCOVA can improve the sensitivity of the statistical test by removing variance due to baseline differences. The variable whose effects are being controlled is the covariate. In this study, the pretest values were used as the covariates. The adjusted means were used to find post exercise

strength differences between groups. Both the t-test and the ANCOVA were performed using the Statistical Package for the Social Sciences (SPSS-x).<sup>19</sup> The significance level for all tests was  $p=.05$ .

## CHAPTER 3

### RESULTS

The results of this study were calculated by analyzing each group of subjects (progressive and regressive) separately to determine if there was a strength gain in either group. Then the groups were analyzed as a whole in order to compare their results and determine if one group increased significantly more than the other. The pretest mean of the progressive resistive group was 67.50 lbs (SD=28.42) and the posttest mean was 75.83 lbs (SD=31.37). The mean increase was 8.33. Table 1 shows descriptive statistics for the progressive group. The regressive resistive group had a pretest mean of 83.57 lbs (SD=29.11) and a posttest mean of 93.57 lbs (SD=32.62). The mean increase was 10.0. Table 2 shows descriptive statistics for the regressive group. Separate paired samples t tests show that both groups did experience a significant strength gain. For the progressive group paired  $t(5) = 5$ ,  $p < .05$ . For the regressive group, paired  $t(6) = 6.48$ ,  $p < .05$ .

When analysis of covariance was used there was not a significant difference between groups on posttest scores when controlling for pretest values,  $F(1,10)=.004$ ,  $p=.953$ . The adjusted mean for posttest scores of the progressive group was 85.44 (SD=1.135) and of the regressive group was 85.34 (SD=1.048).

**Table 1. -- Descriptive Statistics of Progressive Resistive Group**

	<b>Mean</b>	<b>N</b>	<b>Std. Deviation</b>	<b>Std. Error Mean</b>
<b>Pretest</b>	67.5000	6	28.4165	11.6010
<b>Posttest</b>	75.8333	6	31.3714	12.8073

**Table 2.** -- Descriptive Statistics of Regressive Resistive Group

	Mean	N	Std. Deviation	Std. Error Mean
<b>Pretest</b>	83.5714	7	29.1139	11.0040
<b>Posttest</b>	93.5714	7	32.6234	12.3305

**Table 3. -- Analysis of Covariance (ANCOVA)**

	<b>Sum of Squares</b>	<b>Degrees of Freedom</b>	<b>Mean Square</b>	<b>F</b>	<b>Significance</b>
<b>Covariates</b>	12249.327	1	12249.327	1661.538	.000
<b>Main Effects</b>	2.668E-02	1	2668E-02	.004	.953
<b>Model</b>	12249.354	2	6124.677	830.771	.000
<b>Residual</b>	73.723	10	7.372		
<b>Total</b>	12323.077	12	1026.923		

## CHAPTER 4

### DISCUSSION

The results of this study show that both the progressive resistive and the regressive resistive groups gained strength after performing their 5-week training sessions. The mean test value of the progressive resistive group increased by 8.33. The mean of the regressive resistive group increased by 10.0. These results show that both training programs did produce significant strength gains.

The mean value increased by more in the regressive resistive group; however, there was not a significant difference between groups when the analysis of covariance test was used. Although there are very few investigations comparing these two training programs; the studies that have been done favor the regressive resistive program, with the exception of McMorris and Elkins who found results similar to this study.<sup>15</sup>

There were several limitations of this study that may explain the lack of significance between group results. With only 13 total subjects, the sample size was not nearly large enough. In future studies, it would be recommended to use at least 30 subjects in each group. Another limitation of this study was being unable to run the subjects on the programs for more than five weeks. The literature does state that strength can be gained in five weeks; however, there may not have been adequate time for one group to break away from the other in terms of significant strength gains. At five weeks strength gains are still primarily due to neural factors. Muscle hypertrophy doesn't take

over until week three to week five.<sup>13</sup> For future studies, the author recommends running the subjects for 10 to 12 weeks.

### *Individual Differences*

Men generally have the advantage in strength and power output over women due to possessing a greater amount of muscle tissue. There is a positive correlation between the amount of muscle cross-sectional area and the ability to produce force. Since men typically have taller, wider skeletal frames than women, they can support more muscle tissue. A body made up of more muscle and less fat has the potential to exert more force.<sup>10</sup>

As stated earlier, the potential for muscle fiber hypertrophy may be affected by the relative proportion of fast-twitch fibers within a person's muscles. Type II (fast-twitch) fibers show larger increases in cross-sectional area than type I (slow-twitch).<sup>4</sup> Resistance training produces a greater increase in the area of fast-twitch muscle fibers than slow-twitch fibers.<sup>20</sup> People who have low proportions of fast-twitch fibers may have limited potential to increase cross-sectional area of the muscle fibers and, therefore, limited ability to develop force. Differences in muscle fiber composition and number may explain some of the variability in strength gains seen among these groups of subjects. Unfortunately, there is no practical way to determine muscle fiber type proportions in subjects.<sup>10</sup>

The amount of strength gain that occurs is also influenced by whether a person has weight trained or not previous to starting the program. If the subjects have not been involved in any weight lifting prior to beginning the training program, strength gains will



be seen with almost any training program.<sup>10</sup> This is due to a large “adaptational window.” Increases in strength among untrained subjects are relatively easily developed during the earlier weeks of strength training, which is mainly due to neural adaptations rather than muscle fiber hypertrophy.<sup>21</sup> Subjects who may have been weight training prior to beginning one of the programs in this study, more than likely had windows that were already closed.<sup>10</sup> After months or years of training, the ability to elicit adaptations may be the limiting factor to further strength gains.<sup>6</sup> Once all neural adaptations have taken place, it becomes more difficult to see strength gains and the type of training program becomes more important.<sup>10</sup> In this study, the subjects were not asked if they had previously been weight training. While talking with them, some stated they had trained at some point and others said they hadn’t. The two groups may have been unequally weighted with previously trained subjects which would have an effect on the results. In future studies, the author recommends using only subjects who have never weight trained or only subjects who have trained to the same extent in order to eliminate this variable.

Another limitation was being unable to measure muscular effort of the subjects. There are unlimited training methods and each has been supported and refuted by many experts. In the past, the problem has been the inability to validly evaluate these systems due to a lack of any diagnostic tool that can determine effort.<sup>1</sup> The investigator does not know exact muscular effort, but only the weight that has been lifted.<sup>1</sup> It was impossible to determine if each subject was in fact working to their maximum capacity or not. It was essential that the subjects put forth 100% muscular effort since the intensity of muscle overload is what determines strength improvements. Some subjects may have been

working as hard as they could, while others may have been less intense. Everyone works at different levels of intensity.

In summary, each subject brought into these training programs their own genetic predisposition, potential for improvement, and willingness to put forth the effort required to produce a strength increase.

## CHAPTER 5

### CONCLUSION

The purpose of this study was to determine whether there is a difference in strength training outcomes between the progressive resistive program and the regressive resistive program. There is very little research comparing these two programs. The studies that have been done favor the regressive resistive program over the progressive.

The results of this study found a significant strength increase in both groups. This was determined using the paired samples t-test. The ANCOVA test showed no significant difference between groups when comparing strength gains. There were several limitations of the study which may account for these results, including few subjects, limited time to run the subjects, and individual differences between subjects. Each subject brought into these training programs their own genetic predisposition, potential for improvement, and willingness to put forth effort.

Finding the most effective strength training program is important to physical therapists in clinical practice who are under increasing demands by third party payers. Insurance companies are allowing fewer visits per patient forcing physical therapists to rehabilitate their patients in shorter periods of time. The author recommends future studies comparing these strength training programs as well as others. Future studies should consist of more subjects in each group, a longer training period, and subjects who have previously trained for similar amounts of time.

## APPENDIX

☒ EXPEDITED REVIEW REQUESTED UNDER ITEM 3 (NUMBER[S])  
OF HHS REGULATIONS  
☐ EXEMPT REVIEW REQUESTED UNDER ITEM \_\_\_\_\_ (NUMBER[S]) OF  
HHS REGULATIONS

**UNIVERSITY OF NORTH DAKOTA HUMAN SUBJECTS REVIEW FORM**  
FOR NEW PROJECTS OR PROCEDURAL REVISIONS TO APPROVED  
PROJECTS INVOLVING HUMAN SUBJECTS

**PRINCIPAL**

**INVESTIGATOR:** Carrie Brossart

**TELEPHONE:** (701)746-8824 **DATE:** Feb. 14, 1997

**ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT:** 2610 Oak  
St. Grand Forks, ND 58201

**SCHOOL/COLLEGE:** UND **DEPARTMENT:**  
P.T. **PROPOSED PROJECT DATES:** June-Aug.  
1997

**PROJECT TITLE:** A Comparison Study of Strength Training Outcomes  
Between Progressive Resistive Training and Regressive Resistive Training

**FUNDING AGENCIES (IF APPLICABLE):** N/A  
**TYPE OF PROJECT (Check ALL that apply):**

DISSERTATION OR  
☐ NEW PROJECT ☐ CONTINUATION  
RENEWAL ☐ THESIS RESEARCH ☒ STUDENT RE-  
SEARCH PROJECT

☐ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

**DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER:** Mark  
Romanick

**PROPOSED PROJECT:** ☐ INVOLVES NEW DRUGS (IND)  
☐ INVOLVES NON-APPROVED USE OF DRUG ☒  
INVOLVES COOPERATING INSTITUTION

**IF ANY OF YOUR SUBJECTS FALL IN ANY OF THE FOLLOWING CLASSIFICATIONS, PLEASE INDICATE THE CLASSIFICATION(S):**

☐ MINORS (< 18 YEARS)  
☐ MENTALLY DISABLED  
☐ MENTALLY RETARDED

☐ PREGNANT WOMEN  
☐ FETUSES

☐ PRISONERS      ☐ ABORTUSES      ☒ UND STUDENTS (> 18 YEARS)

**IF YOUR PROJECT INVOLVES ANY HUMAN TISSUE, BODY FLUIDS, PATHOLOGICAL SPECIMENS, DONATED ORGANS, FETAL MATERIAL, OR PLACENTAL MATERIALS, CHECK HERE \_\_\_\_\_**

**IF YOUR PROJECT HAS BEEN/WILL BE SUBMITTED TO ANOTHER INSTITUTIONAL REVIEW BOARD(S), PLEASE LIST NAME OF BOARD(S):**

Status: ☐ Submitted; Date \_\_\_\_\_  
Approved; Date \_\_\_\_\_ ☐ Pending

**1. ABSTRACT: (LIMIT TO 200 WORDS OR LESS AND INCLUDE JUSTIFICATION OR NECESSITY FOR USING HUMAN SUBJECTS.**

This study proposes to examine if there is a difference in the strength training outcomes when using the progressive resistive program versus the regressive resistive program; and if so, which program builds strength more efficiently. The results of this study could potentially be useful to both competitive athletes and physical therapists in the clinical setting. Competitive athletes are continuously searching for the most efficient way to build muscle in order to maintain a competitive edge. Physical therapists are under increasing pressure to find the most efficient methods of rehabilitating their patients as current reimbursement trends are allowing fewer and fewer visits per patient. The subjects of this study will be randomly assigned to either the progressive program or the regressive program and will continue their lifting program two times per week for six weeks. Because we are dealing with questions in human strength gains, it is necessary to use human subjects to ensure validity in the study.

**PLEASE NOTE:** Only information pertinent to your request to utilize human subjects in your project or activity should be included on this form. Where appropriate attach sections from your proposal (if seeking outside funding).

**2. PROTOCOL:** (Describe procedures to which humans will be subjected. Use additional pages if necessary.)

Subjects will first perform a three repetition maximum lift using free weights in order to record a baseline. If this is not found within the first three tries, the subject will be asked to stop and try again the next class session. During the next class session, if all subjects have found their baseline, they will be assigned to either the progressive resistive program or the regressive resistive program and will begin following this program for the biceps curl only. They will follow their current weight lifting program for all other lifts. Each subject will first be required to find their ten repetition maximum for the biceps curl using a trial and error method. All subjects will perform three sets of ten repetitions using free weights during each class period which meets twice per week. If all participants agree to lift three times per week, this will be allowed. The subjects assigned to the progressive resistive program will perform their first set lifting 50% of their ten repetition maximum; their second set lifting 75% of their ten repetition maximum; and their third set lifting 100% of their ten repetition maximum. The subjects assigned to the regressive resistive program will perform their first set lifting 100% of their ten repetition maximum; their second set lifting 75% of their ten repetition maximum; and their third set lifting 50% of their ten repetition maximum. After each two week period, if all subjects are able to increase their weights, they will be instructed to do so. If this is not possible, they will wait until the next session. They will continue lifting using their assigned program two to three times per week for six weeks. At the end of the six weeks, each subject will again perform a three repetition maximum lift in the same fashion as they did before beginning the program. Each subject will be required to record the weights they lift each session on a program sheet provided for them.

**3. BENEFITS:** (Describe the benefits to the individual or society.)

This study may help determine which strength training method builds strength most efficiently. This will help the athlete maintain a competitive edge and strength train to his/her fullest potential. It may also benefit the clinical physical therapist who is searching for the most efficient way to build strength while rehabilitating patients, as fewer and fewer treatment sessions are being allowed by third-party payers.

**4. RISKS:** (Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physical risk and includes risks to the subject's dignity and self-respect, as well as psychological, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to insure the confidentiality of data obtained, including plans for final disposition or destruction, debriefing procedures, etc.)

While participating in a strength training class, these subjects are in no danger of injury other than minor muscle injuries such as muscle strains. By taking part in this study, the subjects are under no risk other than those of lifting weights on a regular basis

**5. CONSENT FORM:** A copy of the **CONSENT FORM** to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no **CONSENT FORM** is to be used, document the procedures to be used to assure that infringement upon the subject's rights will not occur.

Describe where signed consent forms will be kept and for what period of time.



Consent forms will be locked in the UND Physical Therapy Dept. and they will be destroyed upon two years after completion of the study.

**6. For FULL IRB REVIEW** forward a signed original and thirteen (13) copies of this completed form, and where applicable, thirteen (13) copies of the proposed consent form, questionnaires, etc. and any supporting documentation to:

Office of Research & Program Development  
University of North Dakota  
Grand Forks, North Dakota 58202-7134

On campus, mail to: Office of Research & Program Development, Box 7134, or drop it off at Room 105 Twamley Hall.

For **EXEMPT** or **EXPEDITED REVIEW** forward a signed original and a copy of the consent form, questionnaires, etc. and any supporting documentation to one of the addresses above.

The policies and procedures on Use of Human Subjects of the University of North Dakota apply to all activities involving use of Human Subjects performed by personnel conducting such activities under the auspices of the University. No activities are to be initiated without prior review and approval as prescribed by the University's policies and procedures governing the use of human subjects.

#### **SIGNATURES:**

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Principal Investigator

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Project Director or Student Adviser

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Training or Center Grant Director

Carrie Brossart  
2610 Oak St.  
Grand Forks, ND 58201  
June 4, 1997

University of North Dakota Institutional Review Board;

I am a graduate student in the department of Physical Therapy. My independent study entitled "A Comparison Study of Strength Training Outcomes Between Progressive Resistive Training and Regressive Resistive Training", was approved by you on February 20, 1997. My project number is IRB-9702-204. Due to the flood, I was unable to complete the study; as I needed to run my subjects through May 2, 1997. I will need to start again with a new group of subjects and plan to run them from June 9, 1997 through August 1, 1997. They will perform the training program two times per week. My new group of subjects are UND students over the age of 18. No other changes to the study have been made.

You may contact me at the above address if need be. Thank you for your time.

Sincerely,

Carrie Brossart

## INFORMATION AND CONSENT FORM

Title: A Comparison Study of Strength Training Outcomes Between Progressive Resistive Training and Regressive Resistive Training

You are invited to participate in a study conducted by Carrie Brossart, a student in the Physical Therapy Program at the University of North Dakota. The purpose of this study is to determine if there is a difference in strength training outcomes between using the progressive resistive theory and the regressive resistive theory; and if so, which one results in larger strength gains. The information gained from this study may help athletes to strength train more efficiently, as well as help physical therapists rehabilitate their patients more efficiently.

Participation in this study will require performing the assigned program twice a week for five weeks at your convenience. You will first be asked to perform a three repetition maximum biceps curl lift using free weights as a measure of your current strength. The following session, you will be asked to find your ten repetition maximum for the biceps curl and will be assigned to either the progressive resistive program or regressive resistive program. Both groups will lift three sets of ten repetitions of the biceps curl. You will need to follow your assigned program for the biceps curl only. You may follow your current program for all other lifts. If you are assigned to the progressive resistive program, you will perform your first set lifting 50% of your ten repetition maximum; your second set lifting 75% of your ten repetition maximum; and your third set lifting 100% of your ten repetition maximum. If you are assigned to the regressive resistive program, you will perform your first set lifting 100% of your ten repetition maximum; your second set lifting 75% of your ten repetition maximum; and your third set lifting 50% of your ten repetition maximum. Every two weeks after the programs are started, attempts will be made to increase weights for all subjects. At the end of five weeks, you will be asked to perform a three repetition maximum again so that a comparison of strength levels before and after participating in these programs can be determined. You will be asked to record your weights during each session.

Any information that is obtained through this study that can identify you will be kept confidential and will not be disclosed without your permission. Your decision whether or not to participate will not prejudice your future relations with the Physical Therapy Department or the University of North Dakota. If you decide to participate, you are free to discontinue participation at any time without prejudice.

You are encouraged to ask any questions concerning this study that you may have now or in the future. Questions may be asked by calling Carrie Brossart at 746-8824. A copy of this consent form is available to all participants in this study.

There is always some degree of risk when lifting weights, such as muscle strains. Although you are at this slight risk by participating in weight lifting activities, this study puts you under no additional risk

In the event that this research activity results in physical injury, medical treatment will be available including first aid, emergency treatment, and follow-up care as it is to a member of the general public in similar circumstances. Payment for such treatment must be provided by you and your third party payer, if any.

**ALL OF MY QUESTIONS HAVE BEEN ANSWERED AND I AM  
ENCOURAGED TO ASK QUESTIONS THAT I MAY HAVE CONCERNING  
THIS STUDY IN THE FUTURE. MY SIGNATURE INDICATES THAT,  
HAVING READ THE ABOVE INFORMATION, I HAVE DECIDED TO  
PARTICIPATE IN THE RESEARCH PROJECT.**

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Participant's Signature

Date

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Witness Signature

Date

## REFERENCES

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